Picking vs Waveform based detection and location methods for induced seismicity monitoring

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Microseismic monitoring is extensively employed in different underground industrial activities related to the production of energy, such as hydrocarbon production and natural gas storage, geothermal energy exploitation or mining. Since these activities can potentially generate induced seismicity, they require the deployment of dedicated microseismic moni- toring networks. If well designed, these monitoring systems allow the detection of very weak earthquakes, even in the presence of strong seismic background noise. Improved de- tection performance, however, will generate extremely large seismic event catalogues and, for this reason, noise tolerant and fully automated data analysis procedures must be estab- lished. Furthermore, microseismic sequences are often characterized by multiple events with short inter-event times or overlapping events; in this case, correct phase identification and event association are challenging, and errors can lead to missed detections and/or reduced location resolution. To overcome these problems, various waveform-based methods for the simultaneous detection and location of microseismicity have been proposed during the last years. These methods exploit the coherence of the waveforms recorded at different stations and do not require any automated picking procedure. Although the adoption of such approaches led to recent promising results, an extensive comparison with sophisticat- ed pick-based detection and location methods is still lacking. In this work we aim to fill this gap by a systematic comparison of the performance of one waveform-based method and two pick-based detection and location methods (SCAUTOLOC and SCANLOC) implemented in the SeisComP3 software package. SCANLOC is a relative new approach used to detect and to locate local and regional earthquakes. The method is based on a cluster search algorithm to associate detections to one or many potential earthquake sources. While the cluster search itself is based on P-phases only, in a second step S-phases are also associated and used for locating the earthquake. We compare the performance of LOKI and SCANLOC with a standard automated pick-detection and location procedure, using the SeisComP3 SCAUTOLOC module. We analyze the performance of the three methodologies for a synthetic dataset as well as for the first hour of continuous waveform data, including the Ml 3.5 St. Gallen earthquake, recorded by a dedicated microseismic network deployed in that area. For the second dataset we compare our detection and location results with a more complete catalogue based on waveform template matching and with a manual revised catalogue.

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